OBSERVATIONS ON THE BLOOD OF NORMAL SUBJECTS DURING FETAL LIVER FEEDING

by

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TABLE OF CONTENTS

INTRODUCTION

Since the discovery in 1926 by Minot and Murphy of substances in liver which are effective in pernicious anemia, continuous efforts have been in progress to obtain correspondingly successful results in the application of liver therapy to the secondary anemias. The erythropoetic role of the fetal liver has led to its being considered as a likely source of a substance which would stimulate hemoglobin synthesis. Dried fetal calf liver was accordingly introduced by Berglund, Watkins and Johnson (1) in treatment of some types of secondary anemia, and favorably reported in 1928. In observation periods of twenty-four to thirty days, these investigators noted an unusual rise in hemoglobin and concluded that this type of liver is effective in accelerating the synthesis of hemoglobin. A case of pernicious anemia refractory to liver extract was also recorded by Berglund and associates (2) as responding to fetal calf liver. Upham and Nelson (3) report favorably upon the use of fetal calf liver in a case of primary aplastic anemia. Sherwood (4) has employed fetal liver therapy in three cases, apparently with beneficial effect.

Watkins, Johnson and Berglund (5, 6) in observations made upon normal individuals, found that there was an immediate and striking increase in erythrocytes upon the ingestion of liver extract. During a ten day feeding period,

they observed this rise in six subjects, as great an increase as 140% of control value being recorded. Acrocyanosis, epistaxis, headaches and other symptoms of polycythemia were noted in their subjects. These investi gators concluded that the substances in liver extract responsible for the appearance of an increased number of red blood cells in pernicious anemia patients, also act in the normal individual.

The present study was undertaken to observe similarly the effect of fetal calf liver on the blood of normal individuals with the hope of demonstrating the salient differences, if any, between fetal calf liver and beef liver extract. Some subjects were given desiccated stomach, and for purposes of comparison with preceding investigations, others were fed liver extract.

Before the completion of this study, Crane, Howard and Murphy (7) reported a series of observations similar to those of Watkins, Johnson and Berglund with far less striking results. They found only a moderate rise in red blood ce lls during a fourteen day liver extract feeding period. Of four subjects, a maximum rise of 700,000 above control values was noted in one subject and not over 300,000 in two others, with reticulocyte counts showing a correspondingly slight rise and subsequently falling slightly below control values.

PROCEDURE

The subjects used were university students between the ages of twenty-one and thirty-one. Of these, eighteen were men, apparently in perfect health, and two were women, both slightly anemic.

Observations were made during and following two different feeding periods, each preceded by a control period of three to seven days. The first feeding period was ten days in length. During this time, five subjects received fifty grams powdered fetal liver daily, the equivalent of 300 grams of fresh fetal liver; two subjects received three vials of #343 liver extract daily, the equivalent of 300 grams fresh beef liver; three subjects received twenty grams desiccated stomach (ventriculin) daily. The observations were continued for twelve days following this feeding period.

The second feeding period employed ten additional subjects. Of these, four ingested a daily dose of 50 gm. powdered fetal liver for thirty-nine days. The fifth subject in this group dropped out early in the series, due to distaste fo r the liver powder. Five control subjects ingested a daily dose of fifty grams chocolate malted milk in a glass of cow's milk, parallelling the fetal liver subjects during the first eighteen days of the second feeding period. One of these subjects, Miss H. C. continued the chocolate malted milk for a total period of thirty-nine days, accompanying Miss I. G. who took fetal calf liver.

The powdered fetal calf liver, liver extract and desiccated stomach were fed after being mixed with fifty grams sweetened chocolate malted milk in a glass of cow's milk to render palatable. The diet of each subject otherwise continued normal.

Observations on the blood were made every other day. Blood for counting and determinations was drawn from an arm vein between 9:30 and 10:30 in the morning. A ten cubic centimeter syringe was used and six cubic centimeters of blood drawn. Of this, one cubic centimeter was placed in a fifteen cubic centimeter graduated centrifuge tube containing exactly one cubic centimeter of 1.6% sodium oxalate solution. Blood for counting was diluted with Hayem's solution and the pipettes were shaken for three minutes in a mechanical shaker. Two dilutions were made from each sample of blood and a count made from each pipette. The count for each day was recorded as an average of the two pipettes. Reticulocytes were counted by the method of Friedlander and Wiedemer (8). Hemoglobin was determined by the Newcomer method, readings being made by north daylight illumination after the acid hematin solution had stood one hour. Hematocrit values were obtained by centrifuging one-half hour at 2500 r.p.m. All enumerations, readings and manipulations in connection with this investigation were made by the same individual.

OBSERVATIONS

(1) Statistically significant variations occurred not only during and following feeding periods, but also in control periods and in control subjects. These significant variations are seen both above and below the usual limits of statistical importance.

(2) Only moderate rises were noted in the erythrocyte and hemoglobin levels during or following feeding periods. No enumerations over 6.44 millions were recorded.

(3) Sudden rises and falls occurred frequently in all subjects, during both control, feeding and post-feeding periods, but no definite periodicity was noticeable.

(4) Withdrawal of fetal liver after a short feeding period results in a decided fall of the erythrocyte level, even to a figure below the normal control level. The drop does not appear as long as liver is continued, not being observed in a 39-day feeding period.

(5) A sustained rise in hemoglobin and cells was noted in one anemic subject taking fetal calf liver daily.

(6) In the three subjects fed desiccated stomach, two showed a slight rise in cell count, and one a more pronounced rise. Two of the three reached a lower

level during or following the feeding period than their initial control level.

(7) In the two subjects fed liver extract, a rise in cell count was noted following the ten day feeding period. One subject shows a noticeable drop below initial control level following this rise.

(8) No increase above normal was noted in subjects one to ten inclusive in reticulocyte count, these being the only subjects in which reticulocyte counts were made.

(9) One subject, subject to frequent nosebleeds, reported an instance of epistaxis during a period of fetal calf liver feeding, but none of the other symptoms recorded by Berglund were observed.

The mean erythrocyte count for each subject's series has been calculated, together with the deviation of each count from the mean. The probable error and the ratio of deviation from mean to the probable error are also given, appearing with the experimental data in the tables which follow. Deviations greater than four times the probable error have been taken as significant, such a deviation arising by chance less often than once in a hundred trials, according to Pearl (9).

DISCUSSION

It is clear from the diagrams showing ratio of deviation from the mean to probable error that statistically significant variations occur not only during and following feeding periods, but during control periods and in the control individuals receiving only malted milk. The statistical importance of readings in a given series being demonstrated, the task remains of establishing any given stimulus as the cause of the significant variations. Such a relationship would be indicated if the response follo wed the stimulus similarly and consistently in a suffi cient number of cases.

Other possible variations which must be considered in weighting the importance of any significant variation in red blood cells are (a) diurnal variations, (b) increases due to exercise, (c) unexplained day-to-day variations and (d) emotional changes. Leake, Kohl and Stebbins (10) found diurnal variations in erythrocyte count averaging as high as 345,000 in six normal men. Hawk (11) in making observations upon athletes, observed that the red cell count might show increases in exercise of from 400,000 to 1,460,000 in a brief period of time, and quotes Willebrand as saying that such rises may be sustained for one and one-half hours. Smith (12) noted that the red cell count may vary from day to day in

statistically significant amounts without observed cause, although she found no significant diurnal variation. Cannon (13) found that the erythrocyte count increases in the cat as much as three million in emotional disturbance.

With statistically significant variations, both high and low, occurring during all periods of both test and control subjects, it is virtually impossible to fix any response as being definitely the result of liver or stomach feeding, due to the difficulty of ruling out the variations named above. One change, however, is striking in its consistency. Withdrawal of fetal calf liver resulted in all five cases observed in a fall of erythrocyte level to a figure below the normal control value. Withdrawal of desiccated stomach showed a drop in one of three subjects, and discontinuation of liver extract showed a pronounced fall in one of the two subjects. In nearly every case, the fall occurs twelve or thirteen days after the feeding has been discontinued. Such a drop in red cell level was not observed during the thirty-nine day fetal liver feeding period.

The fall in red cell level was noted by Berglund and associates, who suggested that it might represent a compensatory mechanism on the part of the body, operating to maintain a normal level of red blood cells. If this supposition is true, fetal calf liver would be classed with liver extract on the basis of stimulating red blood cell production, in that it called forth the same inhibitory mechanism as liver extract.

Miss I. G., a negro student, had been subject to daily nosebleed for some time preceding observation, but the bleedings had stopped when she volunteered as a test subject. A thorough physical and laboratory examination, including roentgenographic, gave absolutely negative findings except a low red blood cell and hemog lobin level. The sustained rise in cells and hemoglobin indicates that fetal calf liver may have been beneficial, although it is manifestly impossible to control normal regeneration.

McHargue (14) has shown that the fresh substance of fetal calf liver contains approximately thirteen times the amount of copper present in the fresh liver of a mature ox. Morrison and Nash (15) observed in the livers of infants six times the average amount of copper present in adult livers. They also noted a very low copper content associated with severe anemia. These observations indicate that fetal calf liver therapy might be particularly beneficial in the type of anemia which seems to be associated with copper deficiency. The liver used in this experiment was prepared from seventy centimeter fetuses, these being observed by Watkins to contain blood-forming islands of a maximum size. The copper content of liver in this age of fetus is as yet undetermined, the observations of McHargue being made on a 5-day premature calf.

SUMMARY

1. Observations were made on eighteen normal subjects and two slightly anemic subjects. Ten subjects were fed fetal calf liver, five for a period of ten days and five for a period of thirty-nine days. Three subjects received desiccated stomach, two rece ived liver extract, and five control subjects received only chocolate malted milk.

2. Variations statistically significant, both high and low, occurred in control periods and in control subjects, as well as during and following feeding periods.

3. Withdrawal of fetal calf liver resulted in a fall of erythrocyte level below the normal control value in the five cases observed. No such fall was observed while fetal liver was continued during the thirty-nine day feeding period. Such a fall occurred also in one of three subjects receiving desiccated stomach, and in one of two subjects receiving liver extract.

4. No periodicity in rise and fall of red blood cell count was observed.

5. One anemic subject, after undergoing liver therapy for forty-five days, showed a sustained rise in erythrocytes and hemoglobin.

6. The effect of fetal calf liver on normal individuals is very similar to the effect of liver extract.

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Subject 1 T. W. Fetal Calf Liver

R.B.C. Mean = 5.54 P.E. = .078

Day of Expt.	Hemoglobin Grams %	R. B. C. Millions	Deviation from Mean	Ratio, Dev. to P. E.
1	16.45	5.51	- .03	.38
3	15.76	5.04	- .50	6.41
5	14.67	5.54	.00	.00
	Fetal Calf Liver Begun Sixth Day			
7	14.67	5.24	- .30	3.84
9	16.17	5.86	+ .32	4.10
11	16.19	5.63	+ .09	1.15
13	14.79	5.25	- .29	3.72
15	15.90	6.00	+ .46	5.90
	Fetal Calf Liver Discontinued 15th Day			
19	15.90	6.18	+ .64	8.21
21	16.45	6.15	+ .61	7.82
23		5.35	- .19	2.44
25	17.19	5.81	+ .27	3.46
27	16.02	5.25	- .29	3.72
28	16.17	4.79	- .75	9.62

Subject 2 J. S. Fetal Calf Liver

R.B.C. Mean = 4.99 P.E. = .0 52

Day of Expt.	Hemoglobin Grams %	R. B. C. Millions	Deviation from Mean	Ratio, Dev. to P.E.
1	14.90	5.02	+ .03	.57
5	13.34	5.41	+ .42	8.07
	Fetal Calf Liver Begun Sixth Day			
7	14.03	5.55	+ .56	10.77
9	14.13	4.98	- .01	.17
11	14.76	4.93	- .06	1.16
13	13.25	5.03	+ .04	.79
15	14.83	4.8 0	- .19	3.65
	Fetal Calf Liver Discontinued 15th Day			
17	13.72	4.93	- .06	1.16
19	13.92	5.0 8	+ .0 9	1.73
21	13.92	4.65	- .34	6.54
25	15.39	4.87	- .22	4.23
27	15.76	4.6 9	- .30	5.77

Subject 3 F. S. Fetal Calf Liver

R.B.C. Mean = 5.10 P. E. = .049

Day of Expt.	Hemoglobin Grams %	R. B. C. Millions	Deviation from Mean	Ratio, Dev. to P.E.
1	13.82	4.92	- .18	3.67
3	14.90	5.51	+ .41	8.37
5	15.39	5.04	- .06	1.23
	Fetal Calf Liver Begun Sixth Day			
7*	16.59	5.28	+ .18	3.67
9	15.51	5.15	+ .05	1.02
11	15.76	4.94	- .16	3.27
13	14.79	5.50	+ .40	8.16
15	15.39	4.92	- .18	3.67
	Fetal Calf Liver Discontinued 15th Day			
18	15.39	5.24	+ .14	2.86
20	15.14	5.13	+ .03	.61
24	16.79	5.11	+ .01	.20
26	15.76	5.04	- .06	1.23
28	15.39	4.52	- .58	11.83

*Epistaxis 8th day

Subject 4 C. O. Fetal Calf Liver

R.B.C. Mean = 5.21 P. E. = .082

Day of Expt.	Hemoglobin Grams %	R. B. C. Millions	Deviation from Mean	Ratio, Dev. to P. E.
4	14.03	5.07	- .14	1.71
6	15.64	4.87	- .34	4.15
	Fetal Calf Liver Begun Sixth Day			
8	13.92	5.75	+ .54	6.59
10	15.39	5.20	- .01	.12
12	14.22	5.11	- .10	1.22
14	14.79	4.83	- .38	4.63
	Fetal Calf Liver Discontinued 15th Day			
18		5.32	+ .11	1.33
20	15.39	5.92	+ .71	8.66
22	16.17	5.89	+ .68	8.29
24	15.14	4.88	- .33	4.02
26	15.76	4.75	- .46	5.61
28	16.17	4.98	- .23	2.80

Subject 5 C. O. Fetal Calf Liver

R.B.C. Mean = 5.52 P. E. = .072

Day of Expt.	Hemoglobin Grams %	R. B. C. Millions	Deviation from Mean	Ratio, Dev. to P. E.
2	15.90	5.70	+ .19	2.64
4	17.03	6.10	+ .58	8.06
6	15.90	5.85	- .33	4.58
	Fetal Calf Liver Begun Sixth Day			
8	14.67	6.18	+ .66	9.17
10	14.44	5.29	- .23	3.20
12	16.02	5.78	+ .26	3.61
14	14.34	5.07	- .45	6.25
	Fetal Calf Liver Discontinued 15th Day			
18	16.02	5.50	- .02	.28
20	15.64	5.66	+ .14	1.94
22	16.31	5.29	- .23	3.20
24	15.14	5.16	- .36	5.00
26	16.59	5.49	- .03	.42
28	14.44	4.71	- .81	11.23

Subject 6 J. H. Desiccated Stomach

R.B.C. Mean = 4.94 P. E. = .030

Day of Expt.	Hemoglobin Grams %	R. B. C. Millions	Deviation from Mean	Ratio, Dev. to P. E.
1	14.13	5.13	+ .19	6.33
7	14.22	4.89	- .05	1.67
	Desiccated Stomach Begun Seventh Day			
9	14.03	4.80	- .14	4.67
11	14.30	4.89	- .05	1.67
13	13.72	4.94	.00	.00
15	15.64	5.07	+ .13	4.33
	Desiccated Stomach Discontinued 15th Day			
17	13.92	4.95	+ .01	.33
19	14.00	4.98	+ .04	1.33
21	15.10	5.22	+ .28	9.33
23	14.22	4.94	.00	.00
25	13.92	4.84	- .10	3.33
27	15.68	4.64	- .30	10.00

Subject 7 E. K. Desiccated Stomach

R.B.C. Mean = 5.10 P.E. = .067

Day of Expt.	Hemoglobin Grams %	R. B. C. Millions	Deviation from Mean	Ratio, Dev. to P.E.
1	13.34	4.49	- .61	9.10
3	13.39	4.38	- .72	10.77
5	13.72	5.30	+ .20	2.98
7	13.72	4.95	- .15	2.24
	Desiccated Stomach Begun Seventh Day			
9	15.64	5.42	+ .32	4.78
11	14.88	5.37	+ .27	4.03
13	13.92	5.35	+ .25	3.73
15	14.67	5.14	+ .04	.60
17		5.08	- .02	.30
	Desiccated Stomach Discontinued 17th Day			
19	15.39	5.52	+ .42	6.27
21	15.02	5.47	+ .37	5.52
25	14.44	4.90	- .20	2.98
27	15.02	4.98	- .12	1.79

Subject 8 A. V. Desiccated Stomach

R.B.C. Mean = 5.73 P.E. = .080

Day of Expt.	Hemoglobin Grams %	R. B. C. Millions	Deviation from Mean	Ratio, Dev. to P.E.
4	15.90	5.69	- .04	.50
6	15.3 9	5.59	- .14	1.75
	Desiccated Stomach Begun Seventh Day			
8	15.39	5.88	+ .15	1.88
10	16.59	6.11	+ .38	4.75
12	15.39	5.46	- .27	3.38
14	15.39	4.93	- .80	10.00
	Desiccated Stomach Discontinued 15th Day			
18	16.59	5.70	- .03	.38
20	16.17	5.90	+ .17	2.12
22	17.03	6.23	+ .50	6.25
24	16.88	6.44	+ .71	8.88
26	16.88	5.44	- .29	3.6 3
28	17.19	5.40	- .33	4.12

Subject 9 K. C. #343 Liver Extract

R.B.C. Mean = 5.75 P. E. = .112

Day of Expt.	Hemoglobin Grams %	R. B. C. Millions	Deviation from Mean	Ratio, Dev. to P. E.
4	12.72	4.61	- 1.14	10.18
6	16.74	5.76	+ .01	.09
	Liver Extract Begun Sixth Day			
8	14.03	5.16	- .59	5.27
12*	15.39	5.98	+ .23	2.05
14	18.17	6.21	+ .46	4.11
	Liver Extract Discontinued 15th Day			
18	17.34	6.37	+ .62	5.54
20	16.45	5.88	+ .13	1.16
22	18.52	6.35	+ .60	5.36
24	17.66	6.07	+ .32	2.86
26	15.39	5.26	- .49	4.38
28	16.35	5.63	- .12	1.07

*Daily dose missed on 11th Day

Subject 10 Q. C. #343 Liver Extract

R.B.C. Mean = 5.27 P.E. = .096

Day of Expt.	Hemoglobin Grams %	R. B. C. Millions	Deviation from Mean	Ratio, Dev. to P. E.
4	14.79	5.44	+ .17	1.41
6	15.26	5.52	+ .25	2.60
	Liver Extract Begun Sixth Day			
8	14.56	5.39	+ .12	1.25
12	14.13	5.16	- .11	1.15
14	14.67	4.95	- .32	3.33
	Liver Extract Discontinued 15th Day			
18	15.90	5.04	- .23	2.40
20	14.03	5.58	+ .31	3.25
22	15.64	5.10	- .17	1.77
24	15.64	5.94	+ .67	6.98
26	17.66	5.69	+ .42	4.37
28	14.44	4.17	-1.10	11.45

Subject 11 H. S. Malted Milk

R.B.C. Mean = 5.25 P.E. = .075

Day of Expt.	Hematocrit	Hemoglobin Grams %	R. B. C. Millions	Deviation from Mean	Ratio, Dev. to P. E.
2		14.67	4.91	- .34	4.53
4		14.56	4.81	- .44	5.87
6		14.79	4.91	- .34	4.53
		Malted Milk Begun Sixth Day			
8		15.14	5.79	+ .54	7.20
10		15.76	5.25	.00	.00
12	47.7	15.14	5.77	+ .52	6.93
14	50.0	15.14	5.30	+ .05	.67
16	48.5	14.44	5.53	+ .28	3.73
18	50.0	15.14	5.45	+ .20	2.67
20	48.7	13.53	4.64	- .61	8.13
		Malted Milk Discontinued 20th Day			
22	49.2	14.67	5.54	+ .29	3.87
24	52.0	15.71	5.03	- .22	2.93

Subject 12 E. H. Malted Milk

R.B.C. Mean=5.11 P.E.=.044

Day of Expt.	Hematocrit	Hemoglobin Grams %	R. B. C. Millions	Deviation from Mean	Ratio, Dev. to P. E.
2		14.56	4.99	- .12	2.73
4		12.89	4.68	- .43	9.78
6		14.56	4.79	- .32	7.27
		Malted Milk Begun Seventh Day			
8		16.74	5.33	+ .22	5.00
10	47.3	15.51	5.29	+ .18	4.09
12	46.3	14.67	5.36	+ .25	5.68
14	48.6	14.56	5.36	+ .25	5.68
16	45.7	14.79	4.99	- .12	2.73
18	47.6	14.22	5.09	- .02	.05
20	50.0	15.14	5.26	+ .15	3.41
		Malted Milk Discontinued 20th Day			
22	47.0	14.90	5.00	- .11	2.50
24	48.8	15.14	5.13	+ .02	.05

Subject 13 J. H. Malted Milk

R.B.C. Mean=5.26 P.E.=.049

Day of Expt.	Hematocrit	Hemoglobin Grams %	R. B. C. Millions	Deviation from Mean	Ratio, Dev. to P.E.
1		15.14	5.02	- .24	4.90
3		12.89	4.94	- .32	6.53
5		15.76	5.24	- .02	.41
6		14.76	5.64	+ .38	7.76
		Malted Milk Begun Seventh Day			
8		15.17	5.45	+ .19	3.88
10		14.90	5.48	+ .22	4.49
12	46.0	13.63	5.39	+ .13	2.65
14	46.0	14.22	5.35	+ .09	1.84
16	47.4	13.72	5.28	+ .02	.41
18	45.1	13.92	4.90	- .36	7.35
20	48.6	14.79	4.91	- .35	7.14
		Malted Milk Discontinued 20th Day			
22	48.3	14.20	5.66	+ .40	8.16
25		13.63	5.18	- .08	1.63

Subject 14 N. F. Malted Milk

R.B.C. Mean=5.32 P.E.=.057

Day of Expt.	Hematocrit	Hemoglobin Grams %	R. B. C. Millions	Deviation from Mean	Ratio, Dev. to P.E.
2		16.88	5.18	- .14	2.46
4		15.64	4.87	- .45	7.89
6		15.14	5.37	+ .05	.88
8		15.14	5.29	- .03	.53
		Malted Milk Begun 8th Day			
10		15.39	5.15	- .17	2.98
12	47.5	15.90	5.18	- .14	2.46
14	51.2	15.90	5.67	+ .35	6.14
16	52.2	15.90	5.28	- .04	.70
18	51.4	15.90	5.11	- .21	3.68
20	49.0	14.34	5.10	- .22	3.69
		Malted Milk Discontinued 20th Day			
22	52.6	15.14	5.84	+ .52	9.12
24	54.5	15.76	5.76	+ .44	7.72

Subject 15 Miss H.C. Malted Milk

R.B.C. Mean=4.23 P.E.=.025

Day of Expt.	Hematocrit	Hemoglobin Grams %	R. B. C. Millions	Deviation from Mean	Ratio, Dev. to P. E.
1		13.25	4.08	- .15	8.00
3		11.42	4.42	+ .19	7.60
5		12.63	4.14	- .09	3.60
7		13.16	4.20	- .03	1.20
		Malted Milk Begun Seventh Day			
9		13.34	4.33	+ .10	4.00
11	40.0	13.16	4.09	- .14	5.60
13	42.0	13.11	4.31	+ .08	3.20
15	43.0		4.15	- .08	3.20
17	39.5	12.07	4.02	- .21	8.40
19	39.8	12.07	4.23	.00	.00
22	44.7	12.72	4.46	+ .23	9.20
24	42.4	12.07	4.08	- .15	6.00
31	42.8	13.43	4.40	+ .17	6.80
38	43.7	11.92	4.37	+ .14	5.60
45	46.3	13.63	4.19	- .04	1.60

Subject 16 H. H. Fetal Calf Liver

R. B. C. Mean = 4.75 P.E.=.064

Day of Expt.	Hematocrit	Hemoglobin Grams %	R. B. C. Millions	Deviation from Mean	Ratio, Dev. to P.E.
1		12.23	4.17	- .58	9.06
3		13.25	4.05	- .70	10.94
5		14.22	4.42	- .33	5.16
7		13.44	4.86	+ .11	1.72
		Fetal Calf Liver Begun Seventh Day			
9		13.63	4.67	- .08	1.25
11	45.0	13.82	4.93	+ .18	2.81
14	48.7	14.44	4.72	- .03	.47
15*	49.4	13.53	4.29	- .46	7.19
17	47.5	15.51	4.86	+ .11	1.72
19	47.0	14.90	5.37	+ .62	9.69
21	46.6	14.67	4.87	+ .12	1.88
23	47.9	14.44	4.80	+ .05	.78
25	47.9	13.07	4.49	- .26	4.06
31	48.7	14.79	5.26	+ .51	7.97
38	51.2	15.02	5.08	+ .33	5.16
45	48.4	14.90	5.10	+ .35	5.47

*Daily Dose Missed 15th, 16th & 17th Days

Subject 17 O. T. Fetal Calf Liver

R. B. C. Mean = 5.00 P.E.= .063

Day of Expt.	Hematocrit	Hemoglobin Grams%	R. B. C. Millions	Deviation from Mean	Ratio, Dev. to P. E.
1		15.39	5.50	+ .50	7.94
3		14.34	4.48	- .52	8.25
5		14.79	4.55	- .45	7.14
7		14.56	4.67	- .33	5.24
		Fetal Calf Liver Begun Seventh Day			
9		13.82	4.50	- .50	7.94
11	48.8	15.39	4.94	- .06	.95
13	49.2	16.67	5.40	+ .40	6.35
15*	51.7	14.40	4.61	- .39	6.19
17	46.8	15.51	4.71	- .29	4.60
19		15.64	5.13	+ .13	2.06
21	51.8	15.76	5.56	+ .56	8.89
23	48.9	14.90	5.12	+ .12	1.91
25	47.5	14.03	4.82	- .18	2.8 6
32	51.3	16.17	4.95	- .05	.79
39	54.2	15.90	5.50	+ .50	7.94
46			5.04	+ .04	.64
52	54.7	17.21	5.52	+ .52	8.25

*Daily Dose Missed 15th & 16th Days

Subject 18 W. B. Fetal Calf Liver

R.B.C. Mean = 5.12 P. E. = .051

Day of Expt.	Hematocrit	Hemoglobin Grams %	R. B. C. Millions	Deviation from Mean	Ratio, Dev. to P.E.
1		15.76	5.37	+ .25	4.90
3		15.39	5.17	+ .05	.98
5		12.55	4.56	- .56	10.98
7		14.44	5.10	- .02	.39
		Fetal Calf Liver Begun 7th Day			
9		14.34	5.34	+ .22	4.31
11	46.6	15.39	5.46	+ .34	6.67
12	48.0	14.67	5.22	+ .10	1.96
14	47.7	15.14	5.48	+ .36	7.06
16*	51.0	13.81	4.57	- .45	8.82
18	48.6	12.07	4.91	- .21	4.12
21	50.8	14.44	5.55	+ .43	8.43
23	48.9	14.90	5.09	- .03	.59
25	47.5	14.67	5.03	- .09	1.77
31	49.5	13.82	4.96	- .16	3.14
38	50.0	13.50	4.72	- .40	7.84
45	49.4	15.64	5.37	+ .25	4.90

*Daily Dose Missed 15th & 16th Days

Subject 19 Miss I.G. Fetal Calf Liver

R. B. C. Mean = 4.04 P.E. = .059

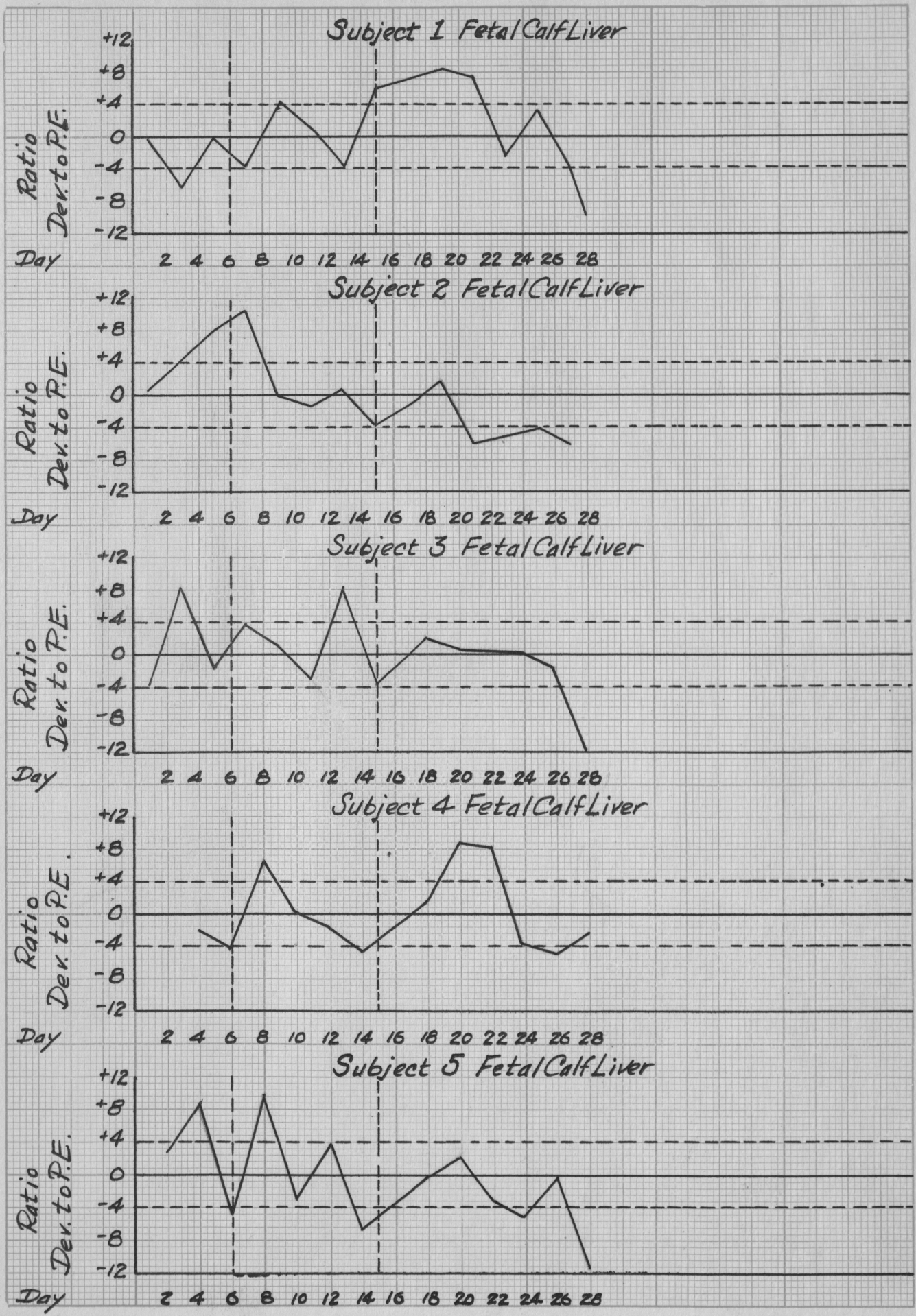
Day of Expt.	Hematocrit	Hemoglobin Grams %	R. B. C. Millions	Deviation from Mean	Ratio, Dev. to P. E.
2		10.42	3.49	- .55	9.32
4		10.54	3.81	- .23	3.90
7		10.54	3.70	- .34	5.76
		Fetal Calf Liver Begun 7th Day			
9		10.42	4.30	+ .26	4.41
11	37.7	10.48	3.99	- .05	.85
14	36.6	10.48	3.98	- .06	1.02
15*	38.7	10.09	3.7 0	- .34	5.76
17	40.0	10.60	4.10	+ .06	1.02
21	40.0	11.63	4.64	+ .60	10.17
23	39.0	11.20	4.44	+ .40	6.78
25	36.2	11.12	3.86	- .18	3.05
32	41.6	11.36	4.44	+ .40	6.78
39	40.4	10.84	4.08	+ .04	.68
52	37.1	11.06	4.07	+ .03	.51

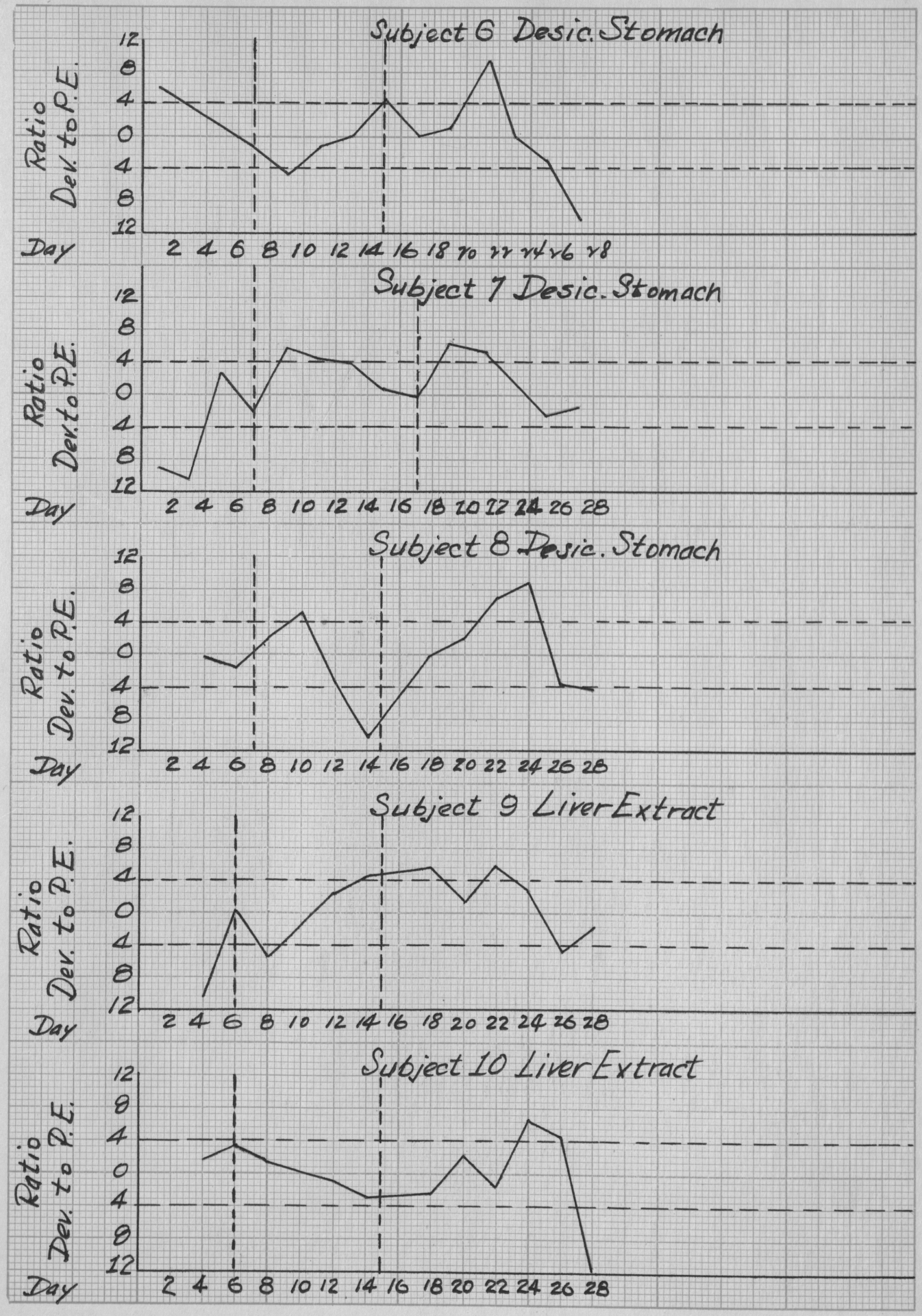
*Daily Dose Missed 15th, 16th, 19th & 20th Days

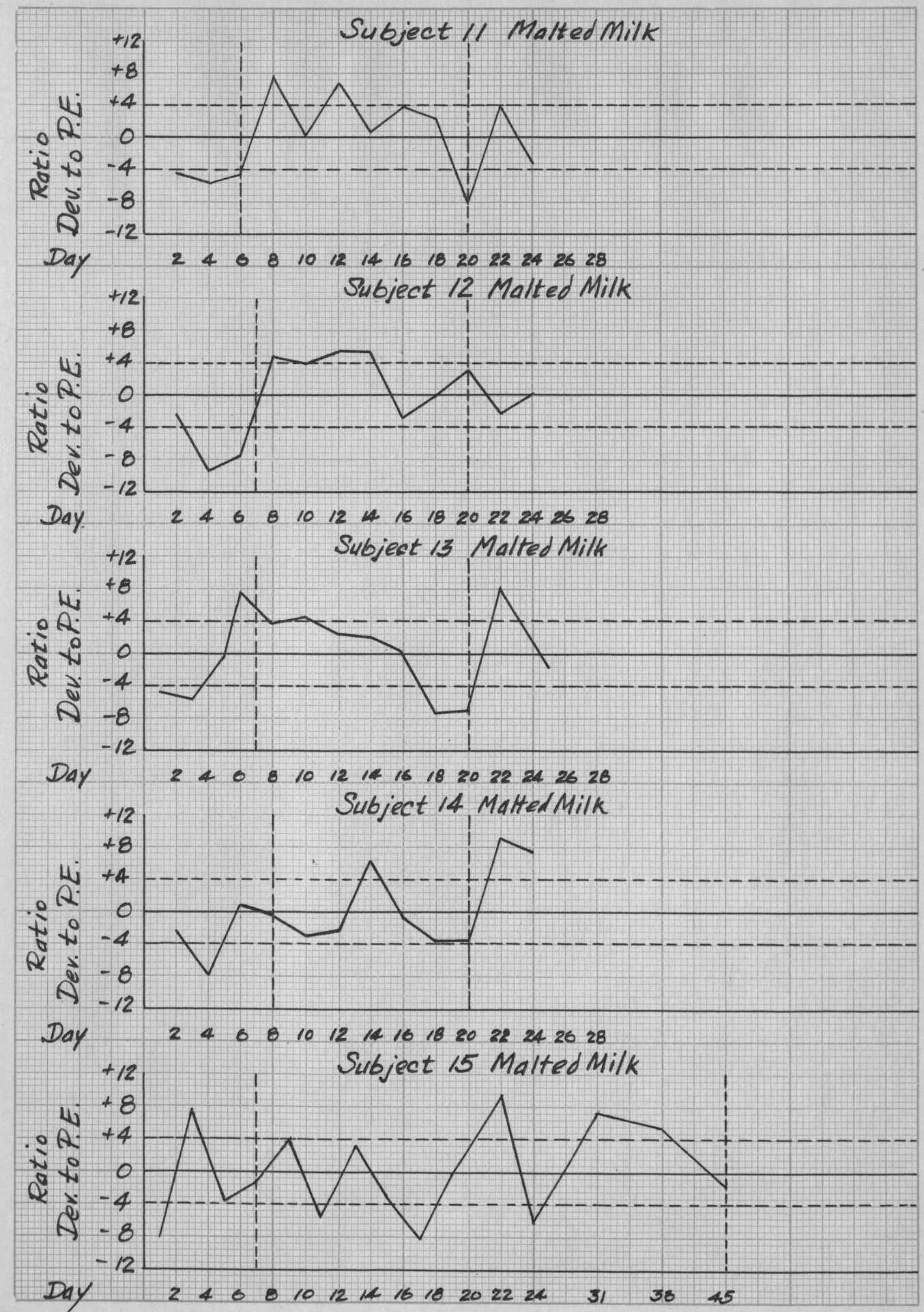
Subject 20 S. M. Fetal Calf Liver

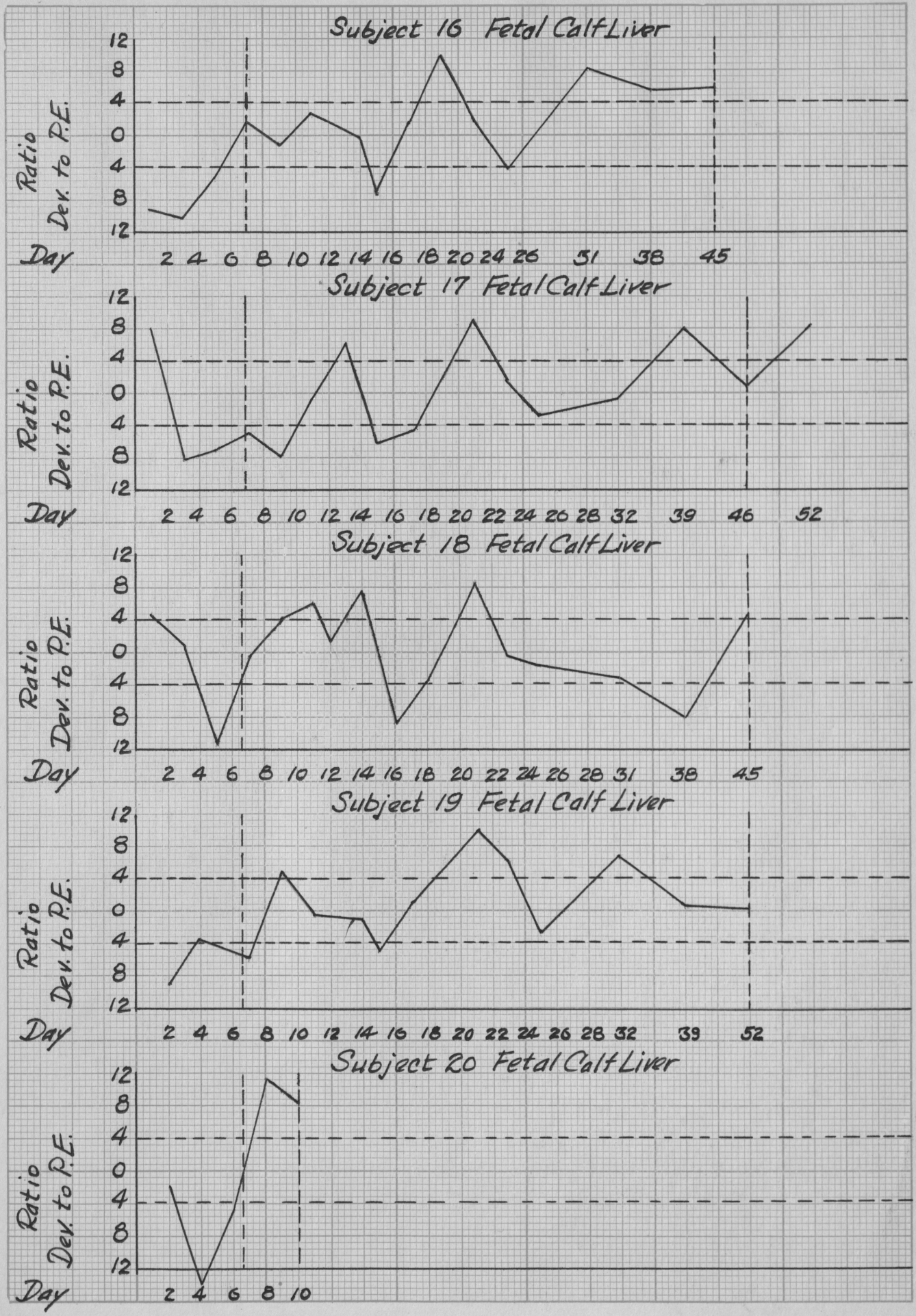
R.B.C. Mean = 4.75 P. E. = .042

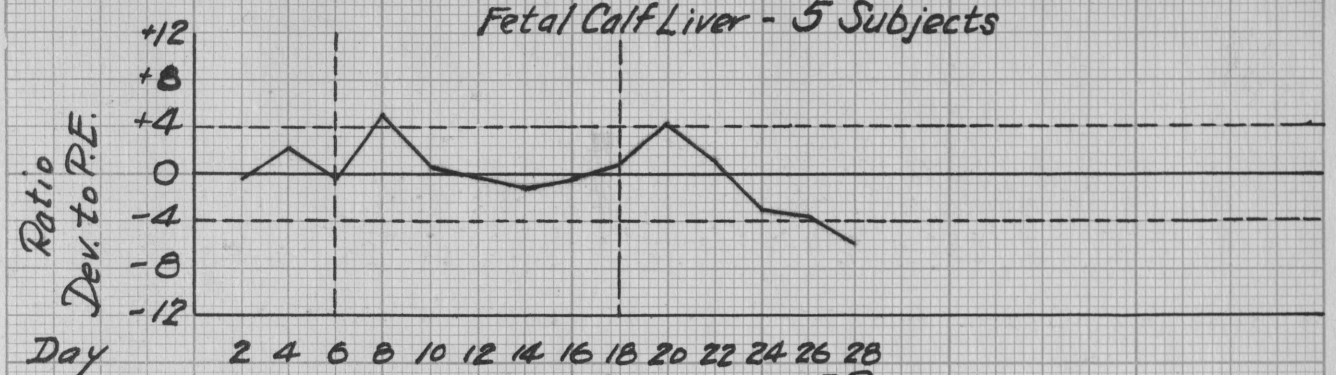
Day of Expt.	Hematocrit	Hemoglobin Grams %	R. B.C. Millions	Deviation from Mean	Ratio, Dev. to P.E.
2		15.14	4.65	- .10	2.38
4		12.55	4.16	- .59	14.77
6		14.22	4.54	- .21	5.00
		Fetal Calf Liver Begun 7th Day			
8		15.90	5.27	+ .48	11.43
10		15.51	5.11	+ .3 6	8.57

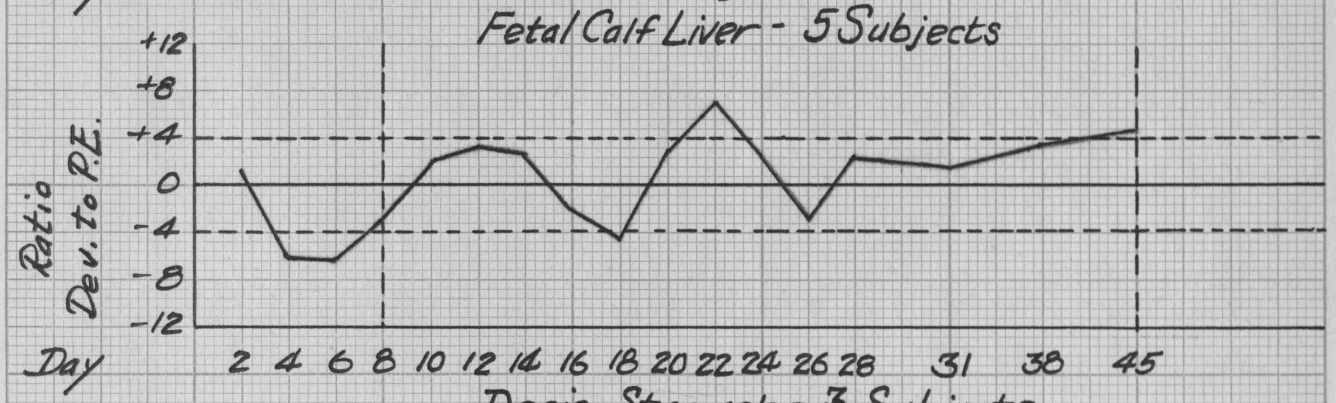

Subject 1 Fetal Calf Liver
Subject 2 Fetal Calf Liver
Subject 3 Fetal Calf Liver
Subject 4 Fetal Calf Liver
Subject 5 Fetal Calf Liver
Ratio Dev. to P.E.
Day
+12
+8
+4
0
-4
-8
-12
2 4 6 8 10 12 14 16 18 20 22 24 26 28

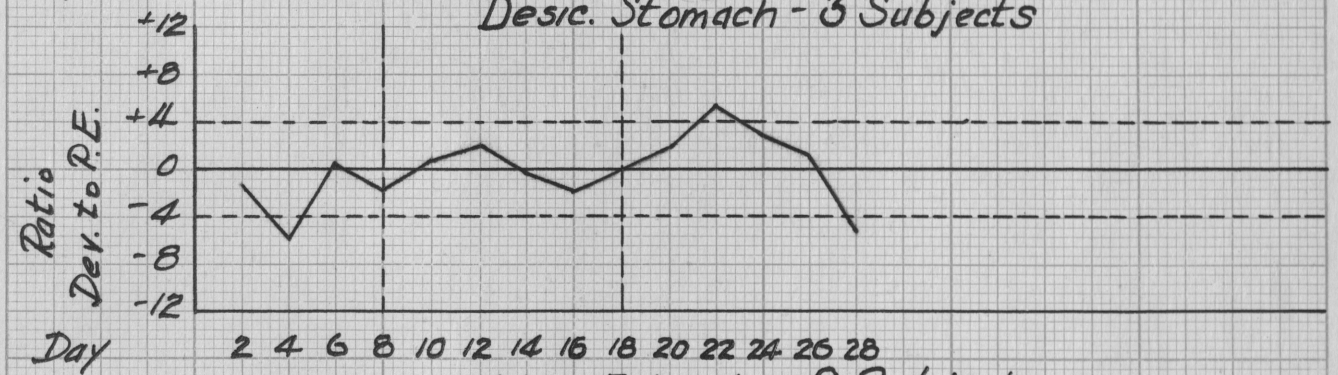

Subject 6 Desic. Stomach
Subject 7 Desic. Stomach
Subject 8 Desic. Stomach
Subject 9 Liver Extract
Subject 10 Liver Extract
Ratio Dev. to P.E.
Day
12 8 4 0 4 8 12
2 4 6 8 10 12 14 16 18 20 22 24 26 28

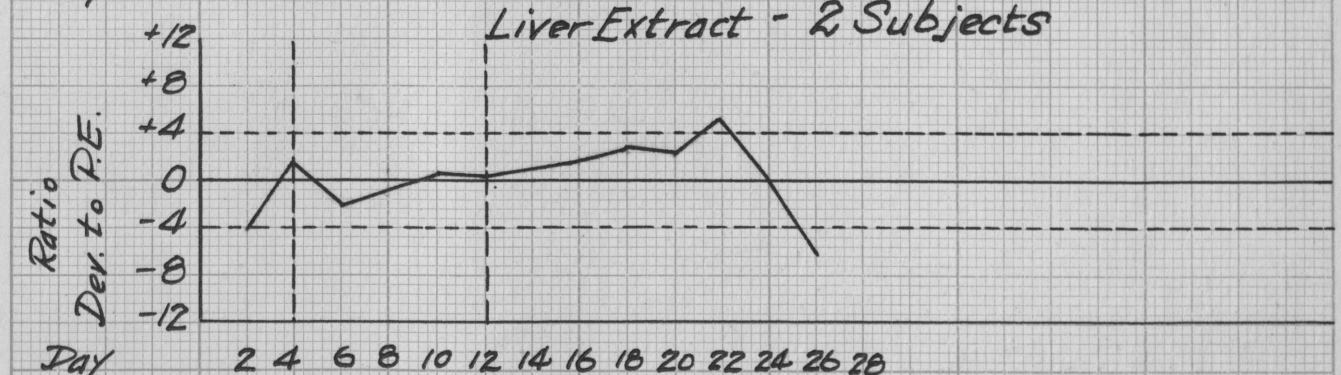

Subject 11 Malted Milk
Subject 12 Malted Milk
Subject 13 Malted Milk
Subject 14 Malted Milk
Subject 15 Malted Milk
Ratio Dev. to P.E.
+12
+8
+4
0
-4
-8
-12
Day
2 4 6 8 10 12 14 16 18 20 22 24 26 28
2 4 6 8 10 12 14 16 18 20 22 24 31 38 45

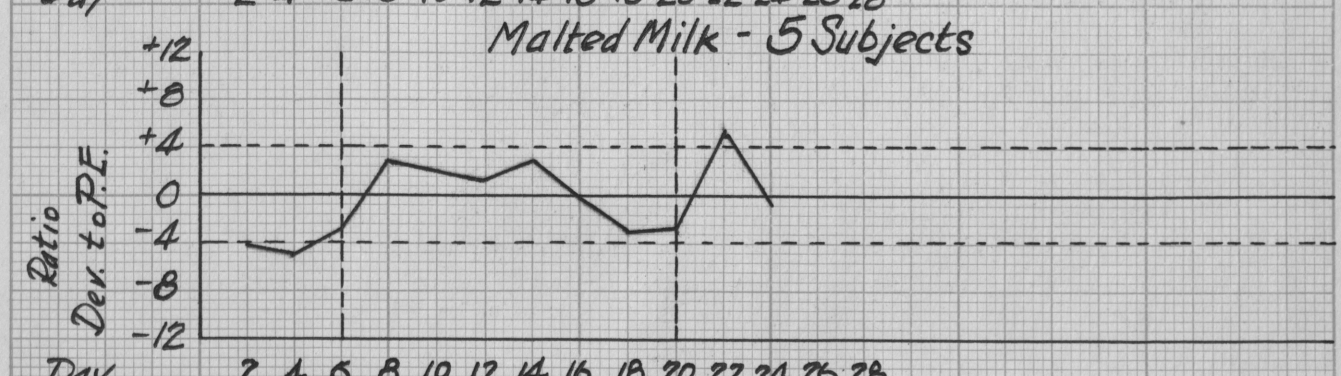

Subject 16 Fetal Calf Liver
Ratio Dev. to P.E.
12 8 4 0 4 8 12
Day
2 4 6 8 10 12 14 16 18 20 24 26 31 38 45
Subject 17 Fetal Calf Liver
Ratio Dev. to P.E.
12 8 4 0 4 8 12
Day
2 4 6 8 10 12 14 16 18 20 22 24 26 28 32 39 46 52
Subject 18 Fetal Calf Liver
Ratio Dev. to P.E.
12 8 4 0 4 8 12
Day
2 4 6 8 10 12 14 16 18 20 22 24 26 28 31 38 45
Subject 19 Fetal Calf Liver
Ratio Dev. to P.E.
12 8 4 0 4 8 12
Day
2 4 6 8 10 12 14 16 18 20 22 24 26 28 32 39 52
Subject 20 Fetal Calf Liver
Ratio Dev. to P.E.
12 8 4 0 4 8 12
Day
2 4 6 8 10


Fetal Calf Liver - 5 Subjects
Ratio Dev. to P.E.
+12
+8
+4
0
-4
-8
-12
Day
2 4 6 8 10 12 14 16 18 20 22 24 26 28


Fetal Calf Liver - 5 Subjects
Ratio Dev. to P.E.
+12
+8
+4
0
-4
-8
-12
Day
2 4 6 8 10 12 14 16 18 20 22 24 26 28 31 38 45


Desic. Stomach - 3 Subjects
Ratio Dev. to P.E.
+12
+8
+4
0
-4
-8
-12
Day
2 4 6 8 10 12 14 16 18 20 22 24 26 28


Liver Extract - 2 Subjects
Ratio Dev. to P.E.
+12
+8
+4
0
-4
-8
-12
Day
2 4 6 8 10 12 14 16 18 20 22 24 26 28


Malted Milk - 5 Subjects
Ratio Dev. to P.E.
+12
+8
+4
0
-4
-8
-12
Day
2 4 6 8 10 12 14 16 18 20 22 24 26 28